cncGraF V1.0

Control Software for CNC Machines

User guide

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2 Basics

The cncGraF software is a program for controlling and operating CNC milling machines with three stepper motors. Command signals are sent via a parallel port (LPT) to the power drivers and then to the built-in stepper motors of the CNC machine. The program also reads and indicates the condition of the three limit reference-switches, the emergency STOP switch, the material height sensor or the tool-length sensor. Two command signals, independent of the other signals, are used for the switching on, with the aid of relays, of the mill spindle motor and the coolant pump.

Step-motors are driven by high frequency impulses created by timer-unit in a PC computer.The WINDOWS operating system does not allow, without the application of an extra external unit (a special controller), for steering in real time. This is because in the Windows system the timer is used for performing multi-task activities. Thus it is not possible to write a program for steering the stepper-motors in real time without the need to apply additional expensive hardware. The program functioning in the MS-DOS environment is free of such limitations.

CncGraF works in the graphics mode and can be controlled completely with a mouse. To enable a quick access to the most frequently used functions, short-cut keys can be applied.

System requirements

Minimum requirements

MS DOS 6.x · PC or Notebook · Processor: 486DX with 33 MHz · VGA-card · VGA monitor · Mouse · 1 MB RAM · Hard disk: 5 MB free

Recommended configuration
MS DOS 6.x · PC or Notebook · Processor: Pentium II with 200 MHz · VGA-card · VGA monitor · Mouse · 1 MB RAM · Hard disk: 10 MB free.

2.1 Program installation

The installation program is on a floppy disk. Please start the install.exe file and installation will begin. Then select a destination file and directory (for example: C:\cncgraf) and press the ENTER key. All program-data files will be copied to the selected destination.

The floppy disc contains the following data files:

cncgraf.exe	cncGraF program
cncgraf.cfg	configuration-data file
cncgraf.wkz	tool-data file
cncgraf.gra	icons of the cncGraF program
egavga.bgi	graphics-data file
help.ger	help-text file –version in German
textmenu.ger	menu-text file – version in German
pulldown.ger	pulldown -text file – version in German
help.pol	help-text – version in Polish
textmenu.pol	menu-text file – version in Polish
pulldown.pol	pulldown-text file – version in Polish
readme.txt	text file with last alterations

Note: *After each new installation of the program, all machine parameters must be set up again (see Chapter 7.8).*

2.2 MS DOS configuration

CncGraF uses the DOS main memory and requires at least 580 KB of free memory. In order to ensure this, you must modify the system files: autoexec.bat and config.sys. The below tables present examples of these system files. They may be used as such in full, with the exception of the mouse setup.

Example - autoexec.bat

```
@ECHO OFF
PROMPT $p$g
PATH C:\DOS;C:\CNCGRAF;C:\MOUSE;
SET LMOUSE=C:\MOUSE
SET TEMP=C:\DOS
LH /L:1,29152 MOUSE
KEYB PL
```

Example - config.sys

```
DEVICE=C:\DOS\HIMEM.SYS /TESTMEM:OFF
DEVICE=C:\DOS\EMM386.EXE RAM x=dc00-dfff
BUFFERS=30,0
FILES=40
DOS=UMB
LASTDRIVE=Z
FCBS=4,0
DOS=HIGH
```

2.3 CncGraF start-up and finish

The program is started up by providing the command: **cncgraf.exe** and pressing the **ENTER** key. If the program is started for the first time or the configuration-data file **cncgraf.cfg** has been accidentally deleted, a choice of language appears. Here, you must select the desired language. Once you do this the main screen of the program shall appear and now you can start the actual work.

When started-up for the first time ever, the basic configuration is loaded. Before the real drilling or milling work can be initiated, this basic configuration MUST be modified. To achieve this it is necessary to select the option **Machine Setup/Parameters** from the menu and enter the characteristics of the machine (see Chapter 7.8). Each time the CncGraF program is started up, a so-called Reference Move must be performed. This makes it possible to determine the ZERO point - in other words, the program shall now recognize the position of the 0,0,0 coordinates point. Without the reference move the program does not

know the position of each of the machine axes. The program is ended with the [**Alt+x**] key combination or by pressing the  icon.

2.4 Menu structure

In order to make the implementation and usage easier, the cncGraF program has been equipped with an innovative, graphically designed interface. The central and at the same time biggest part of the screen is taken up by the **working area.** On both sides of the working area two bars of icons are visible. The user has at his disposal a selection of a choice of several functions: clicking on an icon, the menu, or the short-cut keys.

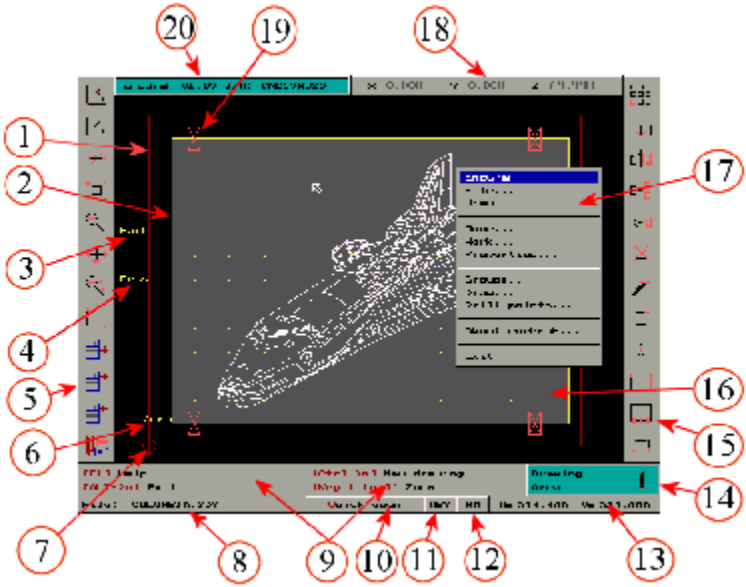

Illustration 2.5 View of the "Machine" screen mode

The program screen consists of the following elements - see illustration 2.5.

1. Machine working area
2. Work-piece scan area with raster points
3. Tool height scan point
4. Park point
5. Functions for loading/saving data
6. ZERO point of work-piece ("relevant zero")
7. Machine ZERO point ("absolute zero")
8. Name of the loaded data file
9. Help
10. Function “Quick load” allows the loading of the last used 5 files
11. Change of the coordinates system between absolute and relative values
12. Change of coordinates units between millimeters and inches
13. The cursor/mouse coordinates
14. Change of the program option between the drawing-area and the machine-area
15. Icon bars, depending on the working option, see point 13
16. Work-piece area (grey colour)
17. Pull-down menu, activated with the left mouse-button .
18. Machine coordinates
19. Holders
20. Program name, version number, and license number

The program is divided into two fundamental parts: the **Drawing-area** (enables the loaded drawing to be edited) and the **Machine-area** (enables a change of the machine parameters). It is possible to change between these areas by clicking on a relevant icon (see illustration 2.5 point 13). In the course of the machine's work some of the functions of the program may be inactive.

Example:
If no file was loaded, or no group exists, the **Duplicate** icon is inactive and the function **Duplicate** in the pull-down menu becomes grey in colour and is not accessible:

The way the functions look in the main menu

inactive function active function

If a function is active, its icon becomes black/coloured.

Pulldown-menu:

Inactive

active

2.5.1 Construction of dialogue windows

All dialogue menus are mouse-controlled. Some dialogue elements can also be controlled with the keypad:

Illustration 2.5.1.1
You can activate the choice buttons with the mouse or with the [SPACE] key.

In the bottom part of the dialogue area buttons are located, for example: "**OK**" and "**Cancel**" (performance of the function or its cancellation). You can select these buttons with the mouse or with the arrow-keys. A selected function is performed with a mouse-click or the [ENTER] key. Each dialogue window, with the exception of the "Unit" dialogue window, can be cancelled with the [ESC] Key.

Illustration 2.5.1.2. Standard buttons

The functions **Open file**, **Save file** and H**elp** offer a data selection list. With the use of the arrow-keys ¯ and - it is possible to move up and down the list, whereas the keys **Page Up** and **Page Down** make it possible to move up and down by one window content.

Illustration 2.5.1.3 : Scroll-bar

The **Location choice** dialogue window is used in many functions so as to introduce a relevant position. The mouse or keypad keys may be used for this purpose.

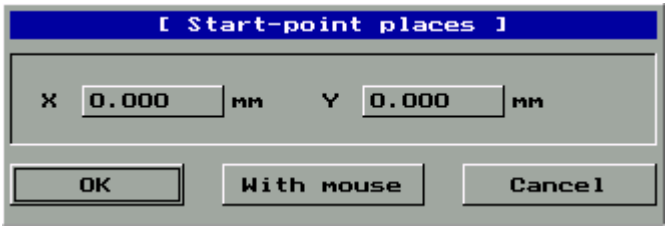

Illustration 2.5.1.4 : The "Location choice" dialogue window

2.3.2 Pulldown menu

The **Pulldown menu** is opened by clicking the left mouse button on the work area. All functions of the program are in the pull down menu. Illustration 2.5.2 shows the complete structure of the pulldown menu .

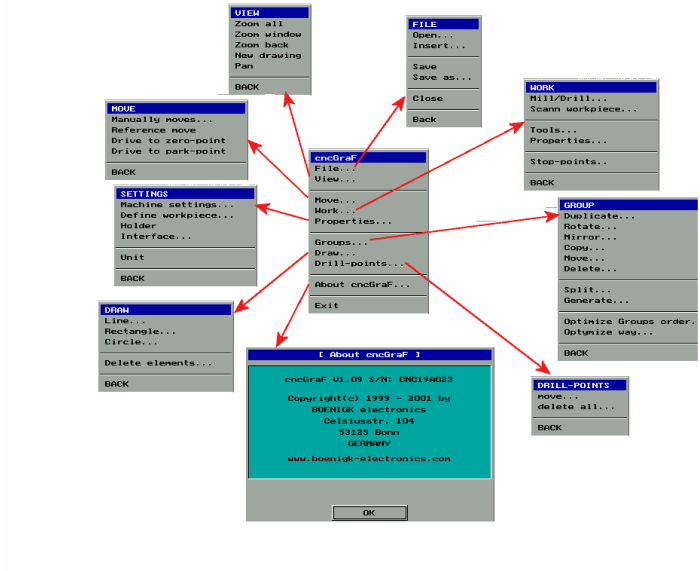

Illustration 2.5.2.1 : Pulldown menu

2.3.3 Help functions

In order to facilitate working with the program an extensive help system has been integrated into the program.

Help in a dialogue window
In each dialogue window it is possible to obtain help by pressing the [F1] key.

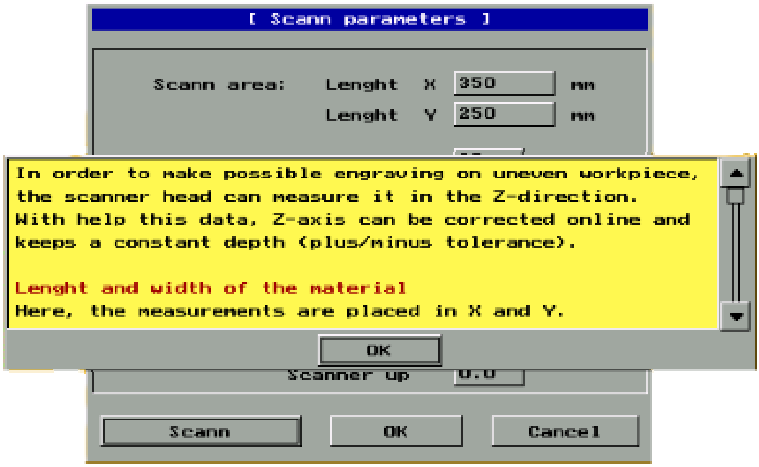

Illustration 2.5.3.1 An example of s help hint.

Help in the main menu

In the main menu pressing the [F1] key initiates the appearance of a help window which offers numerous useful hints.

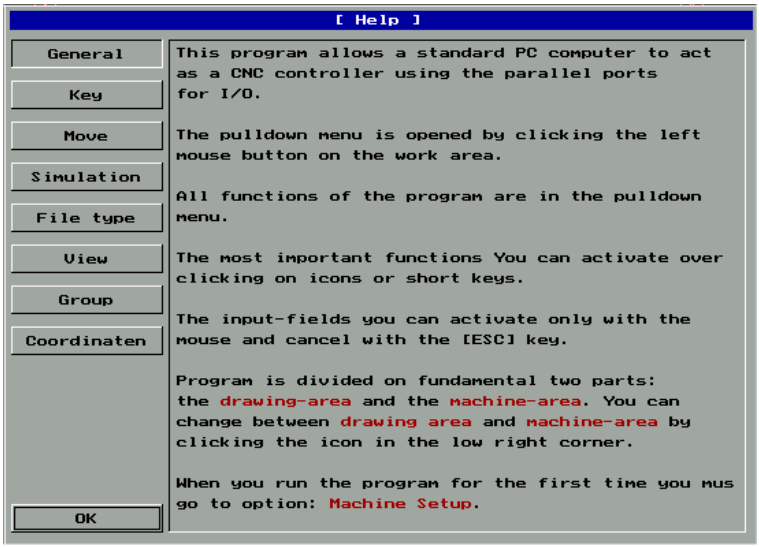

Illustration 2.5.3.2 : Help in the main menu.

Active help

Active help appears for two seconds when the mouse-pointer touches an icon (Illustration 2.5.3.3 Active help):

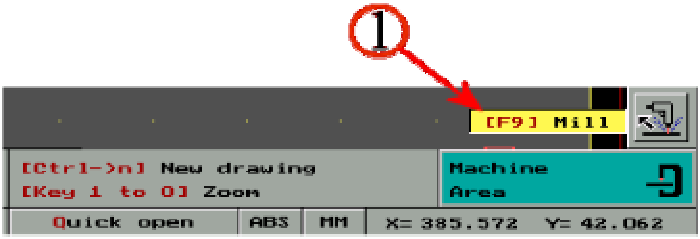

Illustration 2.5.3.3 : Active help

2.4 The coordinate system

The machine coordinate system corresponds to the Cartesian coordinate system. The starting point of the X and Y axes is located in the left bottom corner. Once a Reference Move is performed, the counters for the machine absolute coordinates for axes X and Y are set to value 0 (zero), whereas for axis Z the before set length of axis Z. **Note:** When the Z-axis is moved downward, the value of the Z axis counter diminishes!

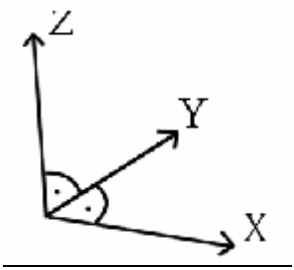

Illustration 2.6 The coordinate system

2.4.1 The mouse coordinate system

The right bottom corner of the screen displays the mouse / cursor coordinates (see Chapter 2.5 Illustration 2.5 Points 10, 11 and 12). These co-ordinates may either be displayed in centimetres or in inches. Additionally, it is possible to switch to and from the absolute and relative values. The relative values have their origin in the ZERO point of the material, whereas the absolute values in the ZERO point of the machine. Icons for switching between the absolute-relative values and the centimetre-inch values are located next to the mouse coordinates.

3 Data files

CncGraF can import different data file formats. In this Chapter, the allowable data file-types are presented.

3.1 Data file-types

CncGraF supports the HPGL, DIN 66025, Execellon, SM1000, SM3000, and DAT CONTOUR2 formats. The read data files can be altered in size / processed by scaling etc.

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3.1.1 Interpreter HPGL

Hewlett Packard Graphics Language, HPGL in short, is a data format generated or exported by almost all CAD-programs. The following HPGL commands are supported by the cncGraF program:

PU;	Tool up
PA100,50;	Move to the absolute position, X=100, Y=50
PR100,50;	Move to relative position, so that the new absolute position is: X200,Y100
PD;	Tool down
CI100;	Circle radius equal 100 counter-clockwise, (for radius -100 clockwise),

AA300,200,50;	Draws a 50-degree-radius arc with its centre at point X300,Y200 and the starting point at 100,50
SP1;	Tool choice (here tool no.1)

3.1.2 Drill data

CncGraF recognizes the following drill data formats: Excellon, Sieb&Maier 1000 and Sieb&Maier 3000.

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3.1.3 Contour2 V2.X DAT interpreter

Contour2 V2.X – a specialist program which has been developed for the conversion of the Gerber format (steering of printed board illumination) to HGPL format to **own DAT format** which makes it possible to use the CNC machine to make engravings on printed boards. The DAT format has been created specially for use in the CncGraF program.

3.1.4 DIN 66025 interpreter

The standardized data file-format DIN 66025 is the standard applied in professional CNC 2½ and 3D machines.

The cncGraF program interprets the following commands:

G-Codes:
G00 Rapid advance
G01 Working speed advance
G02 Circle (Arc) clockwise movement
G03 Circle (Arc) counter-clockwise movement
G04 Pause
G90 Absolute mode
G91 Relative mode

M-Codes:
M00 Stop (the program continues operating upon pressing a key)
M03 Turn on the power feed of the tool
M05 Turn off the power feed
M08 Turn on the coolant pump
M09 Turn off the coolant pump
M30 End of program

Further CNC commands
F Advance rate mm/min
N Task number
T Tool number

The **G00** command moves the tool with the maximum speed rate of the milling machine. The tool is positioned above the material.

Example 1	
DIN 66025	***Description of commands***
N01 **G00 X0 Y0 Z10**	Moves the tool to point **X0, Y0, and Z10**
N02 **M3 M8**	**M3** turns on the drill spindle **M8** turns on the coolant pump
N03 **G01 Z-2 F50**	The tool penetrates the material 2mm deep with the

N04 **G01 X100 Y100 F100**	speed of 50 mm/min. Moves the tool at advance seed rate of 100 mm/min.
N05 **G00 Z10 M5 M9**	to point **X100** and **Y100** Moves the tool to position Z10
N06 **M30**	**M5** turns off the drill spindle **M9** turns off the coolant pump. **M30** end of program.

The **G02** command moves the tool along the arc in a clockwise manner, whereas **G03** moves the tool counter-clockwise. The starting point of the arc is in the current tool position. The end of the arc is determined in commands G2(G3) with the use of commands X,Y and Z, which stand for, respectively, the coordinates for axes X, Y and Z. Commands J and I determine the centre of the circle.
Please find below the control commands for the G2(3) instructions:

X = End coordinates in axis X
Y = End coordinates in axis Y
I = Circle centre in axis X
J = Circle centre in axis Y

Example 2	
DIN 66025	***Description of commands***
N01 **G00 X0 Y0 Z10**	Moves the tool to position **X0, Y0 and Z10**
N02 **M3**	**M3** turns on the drill spindle
N03 **G01 X10 Y10 F100**	Moves the tool at the speed rate of 100 mm/min. to position X10, Y10
N04 **G01 Z-2 F50**	The tool penetrates the material 2mm deep with the speed of 50 mm/min.
N05 **G02 I20 J10 X30 Y10**	Moves the tool along the arc with the arc centre at point I20, J10, from point X10, Y10 to X30, Y10

N07 **G00 Z10** N08 **M30**	Lifts up the tool by 10 mm **M30** End of program

Example 3 illustrates the making of a screw thread (2mm pitch of thread 6 mm long) – 3 coils/convolutions. When making a full circle, the starting point corresponds to the ending point.

Example 3
N01 **G0 X500 Y500**
N02 **G0 Z-5**
N03 **G2 I550 J500 Z-7 F60**
N04 **G2 I550 J500 Z-9**
N05 **G2 I550 J500 Z-11**
N06 **G0 Z0**

The **G04** command enables a delay to be programmed. **G04 H2** denotes a 2-second delay. This function is used, for example, to allow time for the drill spindle to gather speed.

Example 4	
DIN 66025	***Description of commands***
N10 **G04 H2.5**	The tool stops for 2.5 seconds (the drill spindle continues rotating)

The **G90** command sets the coordinate system at the absolute values.

Example 5	
DIN 66025	***Description of commands***
N08 **G90** N09 **G01 X100 Y100** N10 **G91** N11 **G01 X10** **N12** G01 X5 Y-5	Absolute coordinates Moves the tool to position X100, Y100 G91 switches on the relative coordinates Moves the tool to position X110, Y100 Moves the tool to position X115, Y95

The list of control commands may be created under any freely chosen text editor. Small letters may be used but the command code must not contain any blank spaces. It is not obligatory to number the instructions and so numbering may be skipped.

3.2 Working on the data

The **"Open / Insert"** dialogue window makes it possible to enter new or insert / load other data to the files currently open. The construction of a dialogue window is presented in Illustration 3.2.

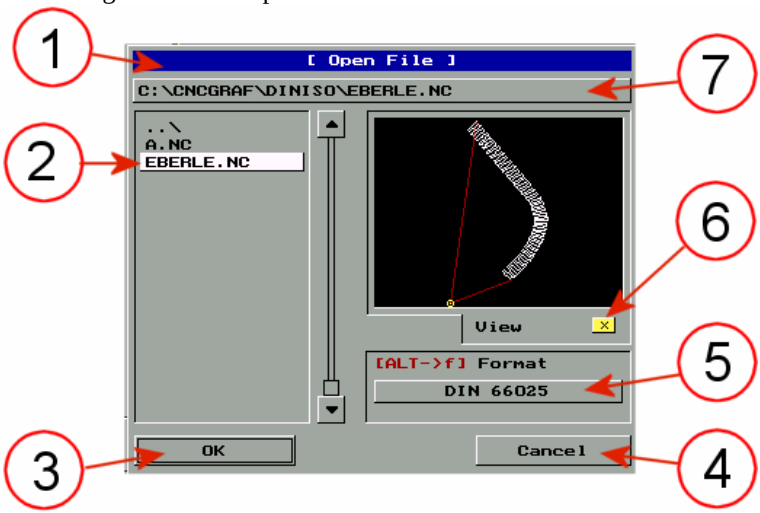


Illustration 3.2
The "Open/Insert file" dialogue window.

1. Window name: **Open** or **Insert file**
2. List of files
3. The "**OK**" button for loading or inserting a chosen data file
4. The "**Cancel**" button closes the dialogue window
5. Selection of data format
6. Preview
7. Input-field for direct input of the access path and the file name. The input-field is activated with the mouse.

3.2.1 Open file

To open a data file click (left mouse button) on the symbol:

The dialogue window **"Open file"** (see Chapter 3.2) shall appear. A list of a selection of files is on the right. The graphic preview enables a preview, on the right, of a selected drawing (illustration 3.2 point 6).

Description	***Key***	***Pull down menu***	***Icon***
Open data file	[F2]	File • Open	

Tip : In order to preview drawings in various formats (HPGL, DIN, etc.), a corresponding format must be selected earlier on.

3.2.2 Quick open file

With the use of this function it is possible to quick open the 5 last opened files (Chapter 2.5 illustration 2.5 point 9).

Description	***Key***	***Pull down menu***	***Symbol***
Quick open 5 last opened data files	none	none	

Tip: If no data files have been opened so far (for instance in the situation when the program is started up for the first time) the function **Quick open** is not available. In this case the relevant button is grey.

3.2.3 Insert file

If a data file has already been loaded or some lines (vectors) have been drawn on the screen, another drawing may be inserted into the file from an outside file. The procedure is then the same as when loading a new file.

Description	*Key*	*Pull down menu*	*Icon*
Insert data	[F4]	File • Insert	

Tip: Inserting is not possible if a format DIN 66025 file has been loaded before. The data file formats DIN 66025 and 3DS cannot be inserted/merged.

3.3 Save data files

The loaded data may be modified in various ways. In order not to lose the modified data we need to store/save it. CncGraF has an individual data saving format 3DS (3D controls).
When saving data for the first time, the "Save as.." function appears automatically. If the data file has already been saved with the .3ds extension, then any changes in the file are saved by pressing the F3 key.

Description	*Key*	*Pull down menu*	*Icon*
Save file on the disc	[F3]	File • Save	
Save file under a new name	none	File • Save as...	none

***Tip*:** If downloaded DIN 66025 data files are not modified in the graphic mode, they cannot be stored/saved.

3.4 Closing data files

Data files are closed in the following manner:

Description	*Key*	*Pull down menu*	*Icon*
Close data file	none	File • Close	none

4 Measurement units

The dimensions of the drawing will not be correct without first setting the right drawing / measurement unit. In order to ease the selection of an appropriate measurement unit, a series of units have been predefined: 1mil, 1/40, 1/100, 1/1000 mm. If none of the predefined units agree with the drawing unit, it is possible to quote one's own unit definition with the use of the keypad. Additionally the loaded drawing may be scaled by quoting a relevant scale.

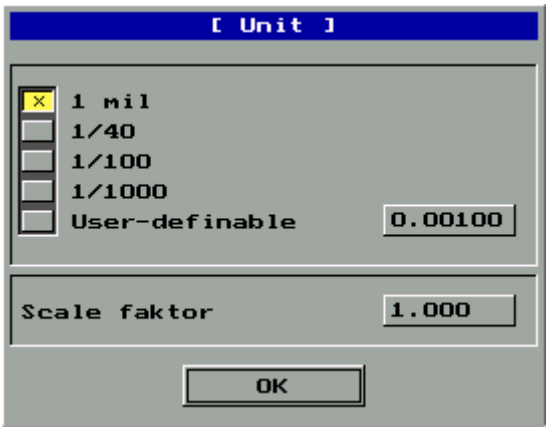


Illustration 4: Selection of the measurement units and the scale of a drawing being loaded

***Tip*:** In the "**Measurement**" option of the menu (Chapter 6.5), it is possible to check whether the selected measurement unit is right. Both the measurement unit and the scale of the drawing may be altered later on.

Description	***Taste***	***Pull down menu***	***Icon***
Change drawing unit and scale	none	Settings • Unit	

5 Zoom functions

The size of the drawing may be enlarged or diminished at any time. In order to achieve this aim you can either use the mouse (clicking on the relevant icon) or the keypad keys from 1 to 0. The "Zoom window" function makes it possible to expand the fragment indicated with the mouse (a rectangle section). The "Pan" function moves the drawing without changing its size.

All the zoom-functions have been listed in the table below.

Description	***Keys***	***Pull down menu***	***Icon***
Zoom a whole drawing to fit	[F5]	View • Zoom all	
Zoom the area indicated with the mouse	[F6]	View • Zoom window	
Move the drawing	[F7]	View • Pan	
Undo zoom	[F8]	View • Zoom undo	
Zoom in / out	[1 to 0] + mouse position	none	none
New drawing	[Ctrl->n]	View • New drawing	none

6 Drawing area

The drawing area presents a series of functions with which the loaded drawing may be processed / edited. The functions in the DRAWING section are available in the pulldown menu at anytime. In order to

simplify the procedure, transition to the DRAWING section is made through clicking on the MACHINE icon (right bottom corner).

Description	***Key***	***Pulldown menu***	***Icon***
Activating the DRAWING mode	none	none	

In the DRAWING section the following icons are at your disposal (sees illustration 6):

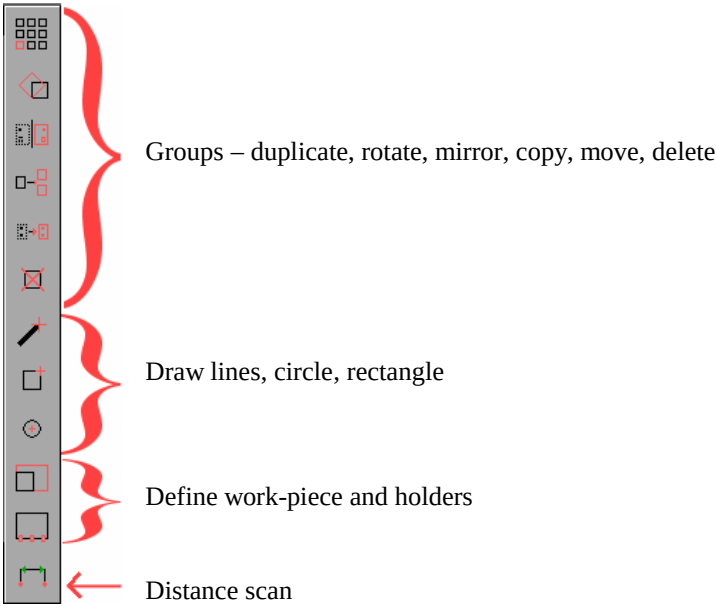


Illustration 6: Symbols in the DRAWING section

6.1 Group and its elements

A **group** is defined as a given number of elements connected with each other in a certain sense. Thus a loaded drawing is such a group consisting of elements – in this case the vectors. Working with groups

makes it easy to copy, move, duplicate, rotate, optimize etc. the elements of the group. A drawing loaded with the menu command "Open" is loaded as a new group.
In order to edit a group loaded earlier on, that is to for example remove one line from the drawing, the drawing must be split into its elements. The **Split group** command serves this purpose. After performing the necessary changes the elements may be combined anew into a group with the command **Generate** group. In this way it is possible to combine single elements from various groups into one new group. Both functions (**Split group** and **generate** group) are displayed on the left side of the screen.
In order to process/edit a group (for example: to copy or duplicate) the group must first be chosen with the mouse. The selected group is marked with a red rectangle (Illustration 6.1.1).

Illustration 6.1 The selected group is marked with a crossed red rectangle

All the newly drawn lines, rectangles and circles (see Chapter 6.2 Drawing) are independent elements (see illustration 6.1.2.) To generate a new group from the independent elements, the function "**Generate group from all elements"** should be used.

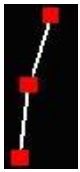


Illustration 6.1.2 Connected elements marked red

All group functions are listed in the table below:

Description	*Key*	*Pull down menu*	*Icon*
Split a group into elements	none	Group • Split	
Generate a new group from all elements	none	Group • Generate	
Duplicate a group	none	Group • Duplicate	
Rotate a group	none	Group • Rotate	
Mirror a group	none	Group • Mirror	
Copy a group	none	Group • Copy	
Move a group	none	Group • Move	
Delete a group	none	Group • Delete	
Delete an element	none	Draw • Delete elements	

6.2 Drawing

CncGraF is not an ordinary CAD-program. The main aim of the program is the controlling / steering of a CNC machine performed on the basis of a loaded drawing. However, the program includes several functions which enable the performance of simple drawing. This is an advantage when the CNC machine is used to cut and process simple

shapes (breakthroughs in front-plates, simple milling, etc.). No specialist CAD program is needed for such operations and the whole work is conducted in the DOS system. All the drawing functions have been discussed below.

6.2.1 Lines and rectangles

Lines and rectangles can be drawn with the use of the mouse or by entering the coordinates directly from the keypad. Each drawn element must be assigned a tool.

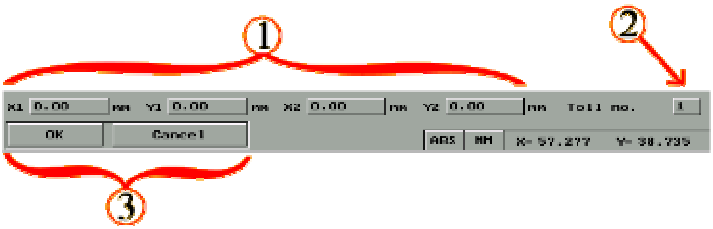


Illustration 6.2.1 The Draw a line or Draw a rectangle dialogue windows are constructed in the same way

1. Coordinate-fields for the first and second point of a line or two opposite rectangle vertexes.
2. Each line and each rectangle must be assigned a tool.
3. The "OK" button or the left mouse-button generates a new object. The "Cancel" button closes the dialogue window.

Description	***Keys***	***Pull down menu***	***Icon***
Draw a line	none	Draw • Line	
Draw a rectangle	none	Draw • Rectangle	

6.2.2 Circles

When applying the **Draw a circle** function any circle may be drawn. The data needed is the centre coordinates, the radius and tool number.

As the first step, the dialogue window "circle centre" appears. The position of the circle centre must be indicated with the mouse or a key. Having done this, a dialogue window appears (see Illustration 6.2.2.) into which the radius and tool number must be entered. Upon confirming the data with the "OK" button the circle shall be generated.

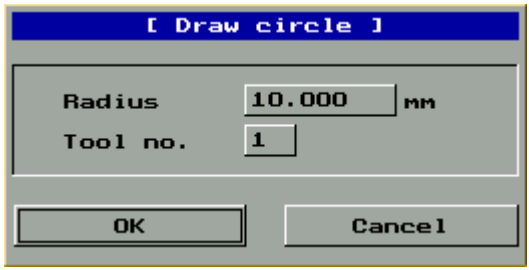


Illustration 6.2.2 The "Draw a circle" dialogue window

Description	*Key*	*Pull down menu*	*Icon*
Draw a circle	none	Draw • Circle	

6.3 Work-piece

For the purpose of visual control, the size of the working area (machine table) and the work-piece may be graphically displayed on the screen.

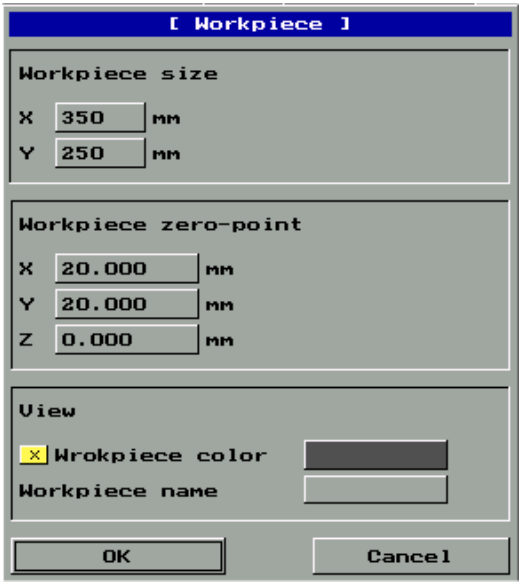


Illustration 6.3 : Work-piece settings dialogue window

Work-piece size:
Here the actual size of the work-piece must be indicated, that is width X and length Y as well as the colour in which it shall be displayed on the screen. This function controls the position of the drawing on the processed material.

Work-piece zero point:
The absolute zero point in absolute values can be set here. This is usually done through moving the cutting tool to an adequate position with the application of the menu function **Manual advance** (see Chapter 7.10 Manual advance, Illustration 7.10).

Note : The Z-axis has its absolute zero point (starting point of the coordinates) at the bottom, at points x0, y0, z0. After a reference move, the Z axis coordinate is located on the length of the Z axis.

Example:	Z-axis length	= 70 mm
	Z-work piece zero point	= 40 mm
	Y- work piece zero point	= 50 mm
	X- work piece zero point	= 50 mm

After a reference move and the subsequent move to point ZERO, the relative coordinates shall indicate X=0, Y=0, Z=30 mm. For safety reasons, the Z axis will not move to point zero Z lying 30 mm deeper.

Description	***Key***	***Pull down menu***	***Icon***
Define the size and point zero of work-piece, and the machine area	none	Settings • Define work-piece	

6.4 Holders

Each work-piece which is to undergo processing must be fastened to the machine table with holders or clamps. To prevent any collisions of the milling/cutting tool with these holders, a special system for indicating the holder points has been introduced (see Illustration 6.4.1).

Illustration 6.4.1: A holder is represented as a crossed rectangle / square

Sizes and positions of the holders can be determined in a dialogue window (see Illustration 6.4.2)

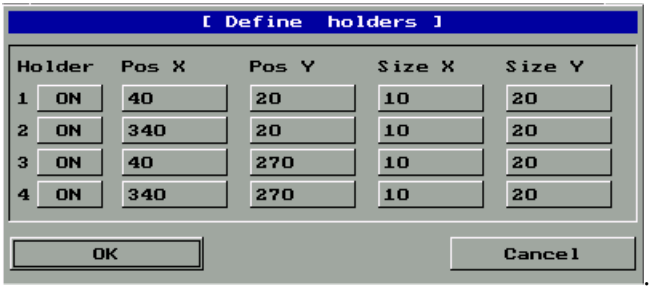


Illustration 6.4.2 : Defining 4 holders

Description	*Key*	*Pull down menu*	*Icon*
Defining holders	none	Settings • Holder	

6.5 Measurement

The **"Measurement"** function is used for measuring the distances, spacing or sizes. Upon clicking, the distance under measurement is displayed, as well as the X-Y coordinates. To facilitate the measurement, it is possible to define a chosen location as a point of reference.

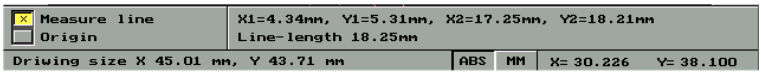


Illustration 6.5 Measuring lines and spacing

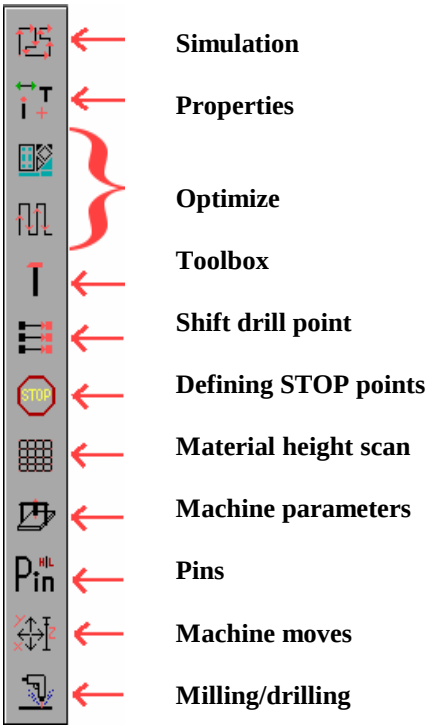
Description	*Keys*	*Pull down menu*	*Icon*
Measurement of lines, spacing and size	none	Settings • Measure	

7 "Machine" area

The MACHINE section is the most important part of the program as it contains functions which determine the specific parameters of the

CNC machine. The MACHINE section is available via the Pulldown menu at anytime. It is easy to switch into the MACHINE mode by clicking on the DRAWING icon.

Description	***Key***	***Pull down menu***	***Icon***
Activate the Machine section	none	none	



Simulation

Properties

Optimize

Toolbox

Shift drill point

Defining STOP points

Material height scan

Machine parameters

Pins

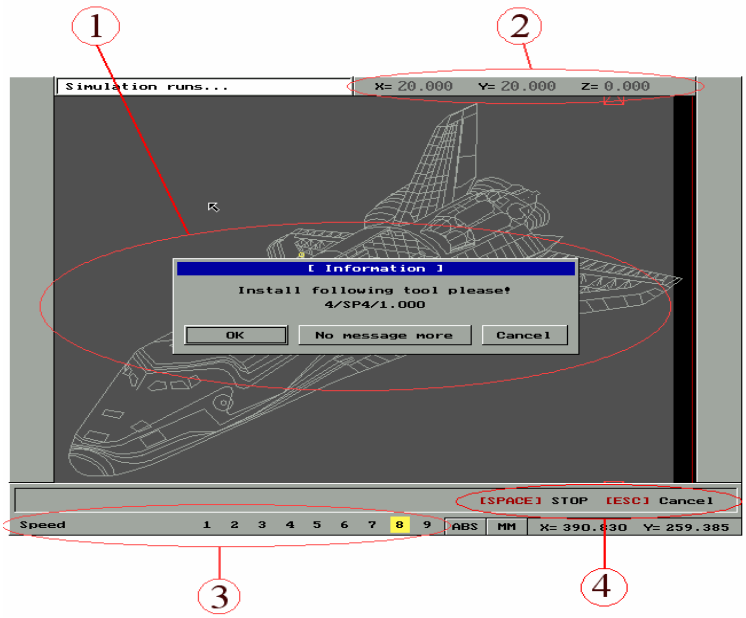
Machine moves

Milling/drilling

Illustration 7 : Icons in the MACHINE section

7.1 Simulation

The simulation function allows for the acknowledgement of the path which the milling tool is to follow in the course of performing actual work. The simulation speed may be changed with the keys – from 1 (slow) to 9 (fast). Performing the simulation prior to the actual work allows for the detection of errors (for example: collision with the holders) and prevents much disappointment.



1. Information displayed at the onset of the simulation or before tool change. The user is informed which tool shall be used next. We can choose between: stop simulation, no further information, continuation.
2. Machine coordinates.
3. Current simulation speed.
4. SPACE-key suspends the simulation (pause). Esc-key ends the simulation.

Description	*Key*	*Pull down menu*	*Icon*
Start of simulation	[Ctrl->s]	none	

7.2 Assigning elements

Here the tool number assigned to a given vector may be changed. As a first step, a vector must be selected. Now select a tool number and confirm the changes with the "**Apply**" key.

Description	*Key*	*Pull down menu*	*Icon*
Assigning properties	[Ctrl->e]	Processing • Properties	

7.3 Optimization

Optimization is applied in order to eliminate / limit the unnecessary machine moves, which, especially with production on a big scale, shall result in considerable saving of time. There are two possibilities of optimization:

- Optimization of group elements.
- Optimization of the sequence of groups.

Optimization, in case of big drawings, requires a fast computer.

***Tip*:** First optimize the path inside the groups, then the sequence of groups.

Description	*Keys*	*Pull down menu*	*Icon*
Optimize sequence of groups	none	Group • Optimize group sequence	

Optimize the path	none	Group • Optimize path	

7.4 Toolbox

The "Toolbox" dialogue window administers up to 99 tools. Parameters for each tool, such as : working speed, immersion-depths, cutter/drill diameter, etc., may be assigned to each tool. The toolbox information is stored in the data file "cncgraf.wkz" upon clicking the "OK" button.

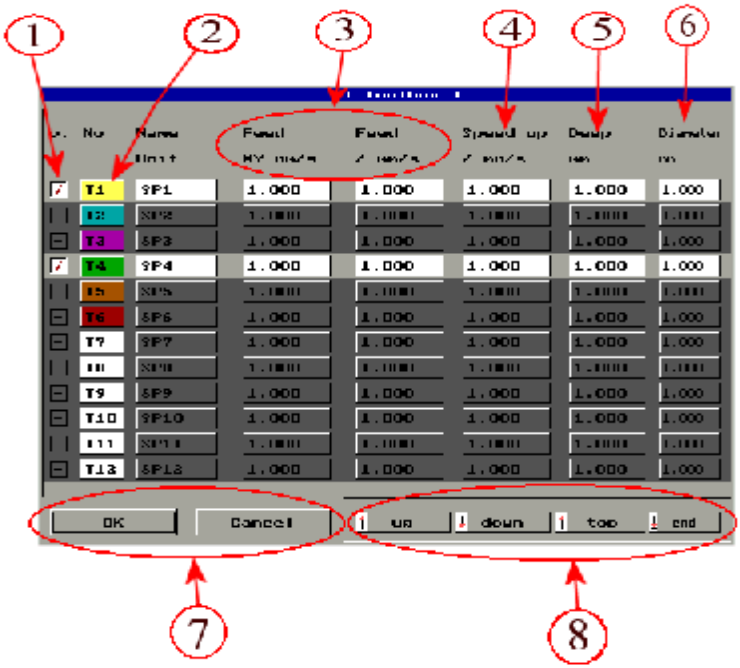


Illustration 7.4 The toolbox

1. The following icons show the status of the tools:
   - Tool is used in the current data file
   -Tool is not used
2. Tool number and current screen colour representation of the tool

3. Working speed for X,Y and Z coordinates in millimeters per minute
4. Working speed for axis Z in millimeters per minute
5. Tool pull out speed
6. Immersion depth
7. Diameters of milling tool, for example the cutter
8. "OK" button saves all the changes introduced into the file, "Cancel" closes the window saving no changes.
9. Keys for scrolling the list.

Description	***Key***	***Pull down menu***	***Icon***
Toolbox	[Ctrl->w]	Processing • Toolbox	

***Tip*:** DIN 66025 data files do not apply the tool data defined in the "Toolbox".

7.5 Drill data

CncGraF recognizes drill data in the Excellon, Sieb&Maier 1000 and Sieb&Maier 3000 format. After loading or inserting a file with drill data it is possible to shift or remove drill points.

Description	***Key***	***Pull down menu***	***Icon***
Shift drill point	none	Drill points • Shift	
Delete all drill points	none	Drill points • Delete all	none

7.6 STOP points

Processing (milling) may be stopped after each group or a poly-line. Suspending work, that is the STOP function, is applied, for example, in order to remove the cut off pieces of material etc.

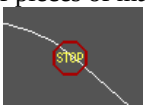


Illustration 7.6 Stop point

Description	*Keys*	*Pull down menu*	*Icon*
Set or remove stop points	none	Processing • STOP points	

7.7 Work-piece height scan

In order to enable the engraving of an uneven material surface, the material height measurement (scanning with an appropriate raster) may be performed first. With the aid of thus acquired data, correction of the Z axis is performed in the course of engraving or milling; in this case the milling cutter penetrates the material to an unchanging and constant depth (+/- tolerance).

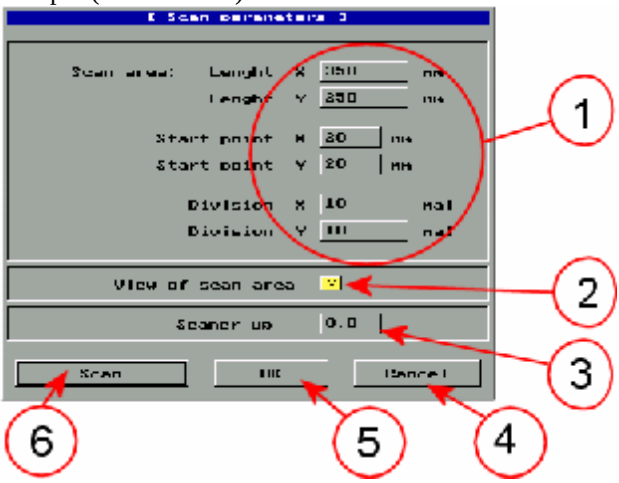


Illustration 7.7 Work-piece height scan parameters

1. Description of loaded parameters:

   Length and width of the material
   Enter the previously measured length and width of the scanned work-piece.

   Start position X, Y,
   In order to avoid error measurement at the edge of a work-piece, the scan starting point should be located at a distance from the edge.

   Division of the material X, Y,:

The number of measuring/test points, that is the so-called **raster**, is calculated by the program on the basis of dividing the length and the width of the material by the value quoted in the material division box. For example, with the length of material equal 100 mm and the stand-off ratio (division factor) equal 5, we shall come up with 6 measuring points distributed every 20 mm.
With considerably even surfaces, to achieve a sufficient height correction precision, few raster points are required. For control purposes the scan area may be displayed on the screen.
On the basis of the measurement data, the cncGraF program calculates the maximum theoretical height deviation between the raster points, which is eventually displayed on the screen. When the deviation exceeds 0.1 mm, this means that the assumed raster is too big or that there has been an error in the mechanics of the sensor.

2. Turn on/off the preview of the scanned work-piece.
3. "Cancel" closes the dialogue window without applying the changes.
4. "OK" closes the dialogue window and confirms all the changes.
5. "Scan" closes the window, adopts all the changes and initiates the scanning of the surface.

7.8 Machine parameters

Once the program is installed, it is required to determine what the parameters of the CNC machine are; the CNC machine is referred to here as the "machine". The parameters must be determined correctly as their wrong introduction may hamper the operation of the machine and may even lead to the damage of the processed material, the milling cutter / the drill or the milling machine.

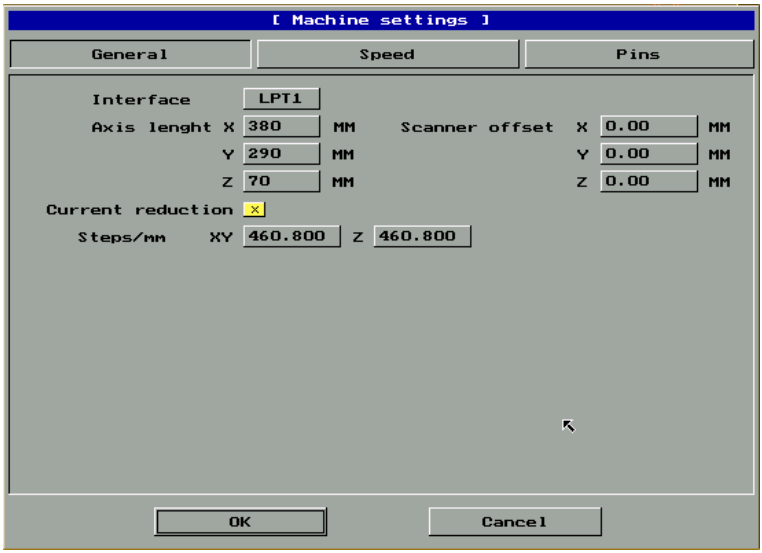


Illustration 7.8 Machine settings – dialogue window

General parameters

Parallel port:
One of the two following ports may be selected: LPT1, LPT2, LPT3 or LPT4. This depends on the number of ports available in the computer and on the number of ports used by other hardware units (e.g. printer, scanner etc.).

Axis-length:
The length of each separate axis is assumed to equal its permissible scope of revolution. On the screen, the scope of revolution of axis X and Y is shown as a red rectangle.

Motor-Current reduction:
It is recommended to apply this option as it protects the motors from overheating at a long period of standby. The logical level at the printer-port with pin 17 reduces the motor-current (sees Chapter 6.9 Signals).

Steps/mm:

The number of steps per 1 mm advance indicates the number of motor steps in one complete revolution divided by thread leap of the spindle-rise.

Example:
Motor-steps per revolution = 400
Spindle-rise per revolution = 2mm
Steps/mm = 400 steps/2 mm = 200

Resolution = 1 mm/200 steps = 0,005 mm/step

The axis-resolution is the linear progress with in the same axis per one motor-step. It is inversely proportional to the steps/mm.

Resolution = 1 mm/200 steps = 0,005 mm/step

Height scan sensor offset:
Here the difference in distance between the height sensor tip and the tool tip is defined (for axes X, Y and Z).

Illustration 7.8.2: Distance between the height sensor and the tool.

How to calculate the offset quickly:

1. Move the machine to **Point Zero** of the material and mark

this position on the material e.g. by scratching the surface with the tip of the milling cutter.

2. Change the machine coordinates to **Relative** and make a note of them.
3. Locate the tip of the height sensor precisely above the marked point.
4. Choose the **"Machine settings"** option from the menu and enter the previously noted coordinates into the Offset area/box.

Speed parameters

Acceleration time of spindle:
Before initiating actual work, it is possible to define a delay essential for the spindle of the tool to achieve the appropriate rotational speed. This function is not active when working on data within the DIN 66025 standards. In this case, the delay time is defined in the program.

Angle difference:
This parameter determines the maximum allowable angle difference between two performed vectors, at which angle the motors shall stop. This value depends on the advance in axis X and Y. If the working advance is $\leq$ than the start/stop speed, then the angle difference may even equal 45 degrees, but at a maximum advance may not be higher than 7 degrees. This value depends on the properties of the applied stepper motors, the weight of the movable parts and the vibration of the machine construction.

Maximum speed:
Maximum speed is the maximum allowable speed at which the machine proceeds appropriately and skips no steps.

Reference move speed:
Same as above.

Start/Stop speed:
To prevent step skipping in the course of accelerating or stopping the motors, the value of this parameter must not be too high.

Ramp gradient:
This parameter defines the acceleration of the motors and is adjustable on levels from 1 to 9. Level 1 indicates the highest rate of acceleration (high gradient), and level 9 the lowest (flat).

Frequency of displaying machine coordinates:
The display of the coordinates is performed in a relatively slow graphic mode. The display of one coordinate digit must take place between the subsequent motor steps. Display time, on the other hand, depends on the speed of the computer. In order to avoid step skipping or a hung-up of the system, a parameter which prevents a display of the coordinates at a greater speed has been introduced.

LTP parameters

Pin numbers for limit/reference switches:
The choice is between pins 10, 11 and 13. Each of these may freely be assigned to a chosen axis X, Y or Z.

Spindle Pin 1:
Depending on the electronics applied, the active level (at which the motor operates) may either be low or high. The level may be changed by activating the tab "Inverse signal to pin 1".

Height scan sensor Pin 13:
If the scan sensor is not connected and yet the message "Active sensor" appears, it is necessary to change the signal level on Pin 13 to the opposite by activating the tab "Invert the signal of the scan sensor".
Emergency switch STOP Pin 15:
Pin 15 is restricted to the emergency switch. If there is no connection, invert the signal level on Pin 15.

Change in the direction of the reference move:
In the course of the reference move, first the Z axis moves upwards until the limit switch switches into operation, and next axes X and Y perform the same operation in a set **reference move sequence**. Once all the axes reach the limit switches, they then move slowly in the opposite direction until the switches are disconnected. The counters for axes X and Y reach the zero value, whereas axis Z is set at the length of this axis.

Change in the move direction:
The move direction may, if needed, be changed freely. The correctness of a set direction may be checked in case of manual advance. Axis X moves forward when pressing the cursor-key →. The ↑ key moves the Y axis forward, whereas the ↓ key moves the Z axis downwards (that is in the negative direction).

Active state of the reference switches:
Depending on the reference/limit switches (usually switched on or off) applied in the machine we select the appropriate option.
To check what type of switches have been installed shift all three axes so that all the switches are released. Then test the logical levels on Pins 10, 11 and 12 in the "**Interface"** menu. If the logical level of pins 10, 11 and 12 is " H ", the switches are switched off. If the level is " L ", then the switches are on.

Description	***Key***	***Pull down menu***	***Icon***
Machine parameters	[Ctrl->m]	Settings • Machine settings	

7.9 Connecting LPT pins

A PC printer port consists of inputs and outputs. The inputs receive external signals emitted by the machine (for example by the limit switches). The computer emits signals to control the machine through the outputs. Clicking the mouse left button on the adequate tab changes its active level to the opposite. Clicking the mouse on Pin 1 switches on or off the

cutter drive. In this manner it is possible to test quickly many functions of the machines.

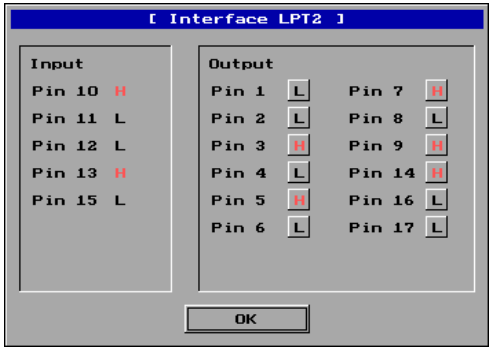


Illustration 7.9 The "Interface" window

Pin 1 Spindle on / off
Pin 2 Direction X
Pin 3 Impulse for motor X
Pin 4 Direction Y
Pin 5 Impulse for motor Y
Pin 6 Direction X
Pin 7 Impulse for motor Z
Pin 8 Free
Pin 9 Free
Pin 10 Limit switch 1
Pin 11 Limit switch 2
Pin 12 Limit switch 3
Pin 13 Height scan or tool length sensor; both may be connected in a parallel manner.
Pin 14 Coolant pump on/off
Pin 15 Emergency STOP switch
Pin 16 Free
Pin 17 Motor current reduction
Pin 18-25 Ground (PC GND)

Description	*Key*	*Pull down menu*	*Icon*
Interface	none	Settings • Interface	

7.10 Machine moves

The "Manual advance" menu includes several functions which govern the advance of the machine. Thus there are the following functions: reference move, manual advance, move to a destined position (move to), move to and back (the machine moves on every axis by a set number of mm and then returns to the starting point), move to the park point, move to the tool length scan and move to point zero of the work-piece (onset of coordinates).

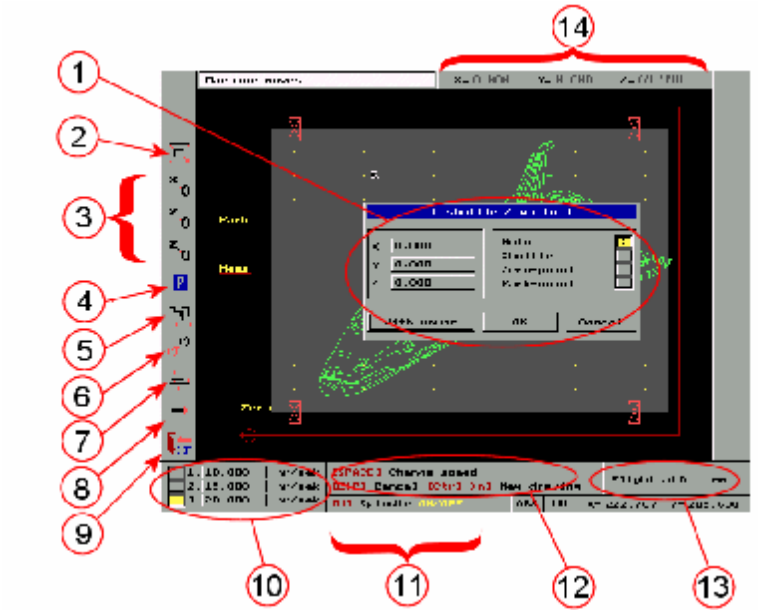


Illustration 7.10: The "Machine moves" menu.

1. Functions *"Move to"* and *"Move to and back"* include several options for controlling the machine. These include the options "Move to" and "Move to and back". In both functions the destination point is determined by entering relevant data with the use of the keypad or by indicating the data on the screen with the use of the mouse. Functions "To ZERO point" and "Park" require no parameters and are accomplished by pressing "OK".
2. "Zoom to fit" scales the drawing in such a way that it fits the screen.
3. Three icons which are responsible for memorizing the work-piece zero X, Y and Z point. This point is represented on the screen as symbol 

4. Clicking on this icon saves the current position of the machine as park point. The park position is graphically represented as symbol 

5. Clicking on this icon saves the current position of the machine as the tool length scan point. The position is graphically represented as symbol 

6. Clicking on this icon initiates the reference move.
7. Clicking on this icon initiates manual move. The speed of the move may be changed with the space bar or a mouse click (see Point 10).
8. This icon opens the "Move to / Move to and back" window with many options (see Point 1).
9. This icon or the ESC key close the "Machine moves" menu.
10. Here you can set 3 different manual advance speed rates.
11. Turn on / off drill spindle motor in the course of manual advance. In this case the machine functions as a conventional milling machine with the option of path length monitoring.
12. Help.
13. The "flight altitude" is a distance between the tool tip (milling cutter) and work-piece in the course of idle advance (above the work-piece).
14. Machine coordinates.

Description	***Keys***	***Pull down menu***	***Icon***
Zoom to fit	[F5]	View • Zoom to fit	
Set work-piece zero point on axis X	[F2]	none	
Set work-piece zero point on axis Y	[F3]	none	
Set work-piece zero point on axis Z	[F4]	none	
Set park point on axis XYZ	[F6]	Move • Park	
Tool length scan point	[F7]	none	
Reference move	[F8]	Move • Reference move	
Manual advance	[F10]	none	
Move to	[F9]	none	
Change speed	[Space]	none	none
Spindle on / off	[M]	none	none
New drawing	[Ctrl->n]	View • New drawing	none

7.11 Milling

Clicking on the icon "Milling" or pressing "F9" starts up the progress of the milling machine. Before the actual start-up, the "Work parameters" dialogue window appears where the last changes in the work settings can be introduced.

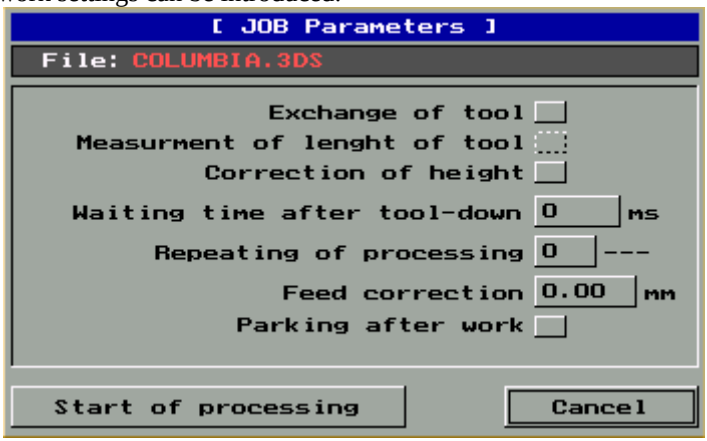


Illustration 7.11 The "Work parameters" dialogue window.

Tool change:
Before each tool change, the machine moves to the park position. A message appears demanding the change of a tool for a different tool.

Tool length scan:
Once the tool is changed the spindle moves to the tool length sensor, which shall perform the scan and on this basis a correction shall be made. A standard micro-switch may be used as a sensor. Once the measurement is done, the processing shall be taken up.

Height correction:
In a situation when the height scan has already been performed previously, the **height correction** option may be activated.

Repeat processing:
The 0 value of the **Repeat processing** parameter means that the processing/milling shall be performed only 1 time. Value 1 means that the processing shall be repeated for one more time, and so on. It is possible for the processing advance to be repeated up to 99 times. This function, along with the correction of immersion depth on axis Z, allows for such processing where the material must be subjected to several working cycles, for example the milling of deep holes in metal, surface grinding etc.

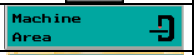
Parking after work:
In this case, once the processing of material is completed, the machine does not move to point ZERO but moves to the previously defined park position. This facilitates the change of material or a tool change.

Description	***Key***	***Pull down menu***	***Icon***
Milling	[F9]	Processing • Mill /Drill	

8 All Functions - overview

Main menu	*Short description*	*Key*	*Pull down menu*	*Icon*
	Help	[F1]	--------	--------
	Split group into elements	------	Group • Split	
	Generate group	------	Group • Generate	
	Delete elements	------	Draw • Delete elements	
	Zoom to fit	[F5]	View • Zoom to fit	
	Zoom window	[F6]	View • Zoom window	
	Pan	[F7]	View • Pan	
	Zoom undo	[F8]	View • Zoom undo	
	Zoom	[1 to 0]	-------	-----
	New drawing	[Ctrl->n]	View • New drawing	-----
	Units and scale	-------	Settings • Unit	
	Insert data file	[F4]	File • Insert	
	Open data file	[F2]	File • Open	
	Quick open data file	------	-------	Quick open
	Define holders	-------	Settings • Holders	
	Save data file	[F3]	File • Save	
	End of program	[Alt->x]	------	
	Save data as….	-------	File • Save as..	-----

Main menu

Description	***Key***	***Pull down menu***	***Icon***
Duplicate group	------	Group • Duplicate	
Rotate Group	------	Group • Rotate	
Mirror group	------	Group • Mirror	
Copy group	------	Group • Copy	
Move group	------	Group • Move	
Delete group	------	Group • Delete	
Draw line	------	Draw • Line	
Draw rectangle	------	Draw • Rectangle	
Draw circle	------	Draw • Circle	
Define work-piece	------	Settings • Define work-piece	
Define holders	------	Settings • Holders	
Measurement/scan	------	Settings • Measure	
Machine area	------	------	
Drawing area	------	------	
Simulation	[Ctrl->s]	------	
Assigning drawing elements to tools	[Ctrl->e]	Work • Assign elements	
Optimize group sequence	------	Group • Optimize group sequence	
Optimize path	------	Group • Optimize path	

Main menu	***Description***	***Key***	***Pull down menu***	***Icon***
	Toolbox	[Ctrl->w]	Processing • Toolbox	
	Shift drill points	------	Drill points • Shift	
	Delete all drill points	------	Drill points • Delete all	------
	Set / delete Stop points	------	Processing • Stop points	
	Work-piece height scan	------	Processing • Scan height	
	Machine parameters	[Ctrl->m]	Settings • Machine parameters	
	Interface	------	Settings • Interface	
	Machine moves	[F10]	Moves • Manual advance	
	Processing	[F9]	Processing • Mill/Drill	
	Cancellation of every activity, function	[ESC]	------	------

Moving menu	***Description***	***Key***	***Pull down menu***	***Icon***
	Save ZERO point for axis X of the work-piece	[F2]	------	
	Save Y Zero point	[F3]	------	
	Set Z Zero point	[F4]	------	
	Set park point XYZ	[F6]	Move • Drive to park point	
	Save/Set tool measure point	[F7]	------	
	Reference move	[F8]	Move • Reference move	
	Moves by hand	[F10]	------	
	Go to	[F9]	------	
	Change speed of feed	[Space]	------	------
	Spindle on/off	[M]	------	------
	New drawing	[Ctrl->n]	View • New drawing	------
	Exit from function Machine moving	[ESC]	------